strata and fauna of this facies not only in Paraná, but also in the state of Matto Grosso, Brazil, Bolivia, Argentina and the Falkland Islands. The work hence possesses a wide scope.

The stratigraphic succession in Paraná is as follows, in descending order: Tibagy sandstone, Ponta Grossa shales, Furnas sandstone. The strata are underlain by an ancient, crystalline complex, and are overlain by Permo-Carboniferous deposits containing glacial till. A very interesting member of this series is the barren, basal Furnas sandstone, which appears to be paralleled by a similar sandstone situated at the base of the Devonian in Bolivia and Argentina. It overlies, at different places, ancient crystallines, Cambrian and Silurian strata, and hence seems to indicate a widespread transgression of the sea in South America at the beginning of Devonian time.

The austral fauna is believed by Dr. Clarke to be of Lower Devonian age, and is considered by him to have sprung from a boreal Silurian ancestry, owing its peculiarities to its development in isolation in southern waters.

One of the most notable aspects of the discussion is the fact, brought out with great clearness, that the American austral Devonian fauna finds its nearest relative in the Bokkeveld fauna of the same age in South Africa. Indeed the species of the Falkland Islands are more closely akin to those of South Africa than they are to those of the state of Paraná.

These relations lead to an interesting reconstruction of the lands and continents of Devonian time. The existence of a more or less intimate connection between Africa and South America had been foreshadowed with greater or less clearness by various writers. The author suggests that an Antarctic continent existed at that time, whose strand stretched from South Africa to the Falkland Islands and thence north into Chile and Argentina, along which the austral species migrated. A large island situated near the present state of Paraná was separated from the Antarctic continent by a comparatively narrow waterway.

A northern land mass embraced the northern part of South America and a large area on the site of the present North American continent. A land bridge is believed to have extended across the north Atlantic ocean, uniting North America and Europe, its existence being indicated by the close relation of the early Devonian faunas of Maine to those of the Coblentz district on the Rhine. It is thought probable that the center of dispersion of the austral species was located in central Africa. The division of the Lower Devonian faunas into a boreal and austral facies and their geographic distribution are explained by these facts.

The larger part of the monograph is devoted to a description and critical discussion of the species constituting the austral Devonian fauna of South America and a consideration of their relations to those of South Africa.

Illuminating comments are made upon the distinguishing characteristics of the austral types in connection with the discussion of the leading groups, the treatment of the characteristics of the trilobites being especially valuable.

The work is published in the English and Spanish languages in parallel columns. Its illustrations are of a high order of excellence. The monograph is a notable contribution to our knowledge of the geology of South America and is a credit both to the author and to the Geological Survey of Brazil.

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Baltimore, Md.

Special Articles

A New Cytological Staining Method

During the course of an investigation on spireme formation and chromosome number in the pollen-mother cells of various species of *Lilium* and *Nicotiana,* considerable time was expended in testing and experimenting with stains and staining processes. In plants such as *Nicotiana,* where the chromosomes are small and the characteristic number is large (48) (24), it is desirable, especially in certain phases of the maturation phenomena, to have a stain combination which will differentiate

chromosomes sharply from the other cell material and at the same time produce a chromosome stain translucent enough so that each chromosome in a crowded equatorial plate will stand out by itself. In the synapsis condition of the spireme, a translucent but extremely "contrasty" differentiation between the tightly massed thread and other cell materials was also thought desirable. Flemming's safranin, gentian violet, orange G combination and iron hematoxylin were usually unsatisfactory in attempting to secure the sought-for results.

Magdala-red was tested out after the methods given by Chamberlain,[1] but with unsatisfactory results. Both strong and weak solutions of the stain were used, but for chromatin and chromosome staining it never appeared to possess "body" enough to give a sharp contrast when used with anilin-blue or other blue cytoplasmic stains. After a preparation had been in the stain bath for 24 hours, the red color easily washed out during the hurried passage through acid alcohol, 95 per cent. neutral alcohol, etc., to xylol. Occasionally fair preparations were obtained, but when these were examined by artificial light, the red stain, through lack of "body," lost its brilliancy and contrast value.

The thought occurred to try mixing magdala-red with safranin O, and thus remedy the "lack of body" defect of the former and increase the brilliancy and translucency of the latter. Accordingly, a solution of safranin, made up of equal parts saturated solution of safranin O in 50 per cent. alcohol and a saturated solution of safranin in a 3-per-cent. solution of anilin oil in water, was mixed with a strong (saturated) solution of magdala red in 9 per cent. alcohol. The precipitate thrown down upon mixing the two stains was eliminated by filtering and the red solution remaining was used as the stain. Serial section preparations on the slide were allowed to remain in this stain for varying lengths of time—24 hours in most cases, after which they were treated with anilin-blue, etc., after the method as given by Chamberlain, p. 48. Many variations in method were practised; the main thing being to allow the red stain to act for a long time and the blue a very short time. The necessity of using the hydrochloric acid to bring out the brilliancy of the anilin-blue and to produce the desired contrast effect made the process undependable where good preparations were constantly desired. In other words, where only a small amount of material was to be had and every slide preparation must be made to count, as in much research work, the method was not a practicable one.

In order to eliminate the use of acid, the anilin-blue was discarded, and a saturated solution of azure II was substituted. This combination of magdala-red-safranin and azure II gave in most cases good results. A brilliant red and blue were both obtainable without the use of acid. From the solution of magdala-red-safranin, the slide was dipped directly into the azure II, allowed to remain about a second, and then rushed through the higher alcohols to xylol and neutral balsam. Variations in practise were common and it has been my intention here merely to indicate the general method. In many cases, satisfactory results were obtained by shortening the bath in the red stain to an hour or even to 30 minutes.

Preparations of reduction division stages in the pollen-mother-cells of *Lilium canadense* L. were stained as follows: cytoplasm, deep brilliant royal blue or greenish blue; spindle fibers dark blue and sharply outlined against the cytoplasm; nucleoli, usually blue in active and red in "resting" nuclei, chromatin substance (spireme, etc.) brilliant deep ruby red. Preparations of pollen-mother-cells of *Nicotiana* in early prophase have been obtained in which the vacuolated nucleoli were stained blue and little beadlike globules within the nucleolar vacuoles shown brilliant red. The chromatin is aways stained a brilliant red and against the background of dark blue cytoplasm the contrast is extremely sharp. Chromosomes in those plants where their numbers are large are ordinarily counted with extreme difficulty, even under the most favorable conditions, owing to the crowding of the chromosomes on

[1] "Methods in Plant Histology," 2d ed., 1905, pp. 42, 44, 47–48, 79–83.

the spindle. The process just described will, I believe, partially eliminate this difficulty, as the red is somewhat translucent and each chromosome seems to stand out by itself, even when one lies above the other. Mature pollen of *Lilium tigrinum* Ker. when fixed in Flemming and embedded and sectioned in the usual manner reacts to the process as follows: outer wall, sculpturing, etc. (perine), bright red; extine, intine and cytoplasmic structures blue or bluish green; chromatin granules and nucleoli in "resting" nuclei, red; other nuclear material blue; nuclei as a whole well differentiated from surrounding cytoplasm.

Orland E. White
Brooklyn Botanic Garden,
January 31, 1914

THE AMERICAN MATHEMATICAL SOCIETY

The society held two large meetings during the Christmas holidays, one at the University of Chicago on December 26–27, the other at Columbia University on December 30–31. The New York meeting was the annual meeting of the society, and was especially marked as the occasion of the presidential address of Professor H. B. Fine, on "An Unpublished Theorem of Kronecker Respecting Numerical Equations."

Eighty members attended the four sessions. Professors W. F. Osgood and H. B. Fine occupied the chair in succession. The following new members were elected: Professor Pierre Boutroux, Princeton University; Mr. E. H. Clarke, Purdue University; Dr. W. H. Cramblet, University of Rochester; Mr. H. J. Ettlinger, University of Texas; Professor W. S. Franklin, Lehigh University; Mr. H. Galajikian, Princeton University; Professor W. W. Hart, University of Wisconsin; Mr. Barnem Libby, University of Michigan; Mr. G. W. Mullins, Columbia University; Mr. J. A. Northcott, Columbia University; Dr. Mildred L. Sanderson, University of Wisconsin; Mr. J. M. Stetson, Princeton University. Nine applications for membership were received. The total membership of the society is now 710, including 66 life members.

The Treasurer's report shows a balance of $9,153.58. Sales of publications during the year have amounted to $2,111.45. The library has increased to 4,902 volumes. The number of papers read at all meetings was 240.

At the annual election the following officers and members of the council were chosen:

Vice-presidents: L. P. Eisenhart and E. J. Wilczynski.
Secretary: F. N. Cole.
Treasurer: J. H. Tanner.
Librarian: D. E. Smith.
Committee of Publication: F. N. Cole, Virgil Snyder, J. W. Young.
Members of the Council to serve until December, 1916: C. N. Haskins, L. M. Hoskins, E. V. Huntington, H. L. Rietz.

The annual dinner, on Tuesday evening, was attended by forty-seven members.

The Madison Colloquium Lectures, delivered last September by Professors L. E. Dickson and W. F. Osgood, are now in press and will soon be published by the society.

The following papers were read at the annual meeting:

L. L. Dines: "Complete existential theory of Sheffer's postulates for Boolean algebras."
Arnold Emch: "Two convergency proofs."
J. L. Coolidge: "Congruences and complexes of circles."
Dunham Jackson: "On the degree of convergence of Sturm-Liouville series."
Virgil Snyder: "Birational transformations of the cubic variety in four-dimensional space."
Miss A. H. Tappan: "Plane sextic curves invariant under a group of linear transformations" (preliminary communication).
C. L. Bouton: "Explicit formulas for the inverse of an analytic transformation in n variables."
Edward Kasner: "The classification of conformal transformations."
L. B. Robinson: "Questions of logic arising from the study of systems of partial differential equations" (preliminary report).
Pierre Boutroux: "On a family of rational differential equations of the first order."
H. B. Fine, presidential address: "An unpublished theorem of Kronecker respecting numerical equations."
W. A. Hurwitz: "Note on the Fredholm determinant."
G. D. Birkhoff: "The restricted problem of three bodies."
E. V. Huntington: "On the accuracy of the contracted form of Horner's method."
O. E. Glenn: "On an analogy between formal modular invariants and the class of algebraical invariants called Booleans."
G. C. Evans: "Green's functions for linear partial differential equations of the second order, and Green's theorem."
W. R. Longley: "An existence theorem for a certain differential equation of the nth order."
W. C. Graustein: "The real congruence of complex points, planes, lines."
H. W. Reddick: "Conformal invariants of orthogonal curve nets" (preliminary communication).